Revision 09/04

CORRES. CONTROL
OUTGOING LTR NO.

DOE ORDER #
05-RF-00879

DIST.	LTR	ENC
FERRERA, D.W.	X	X
GIACOMINI, J. J.		
GILPIN, H.E.		
LINDSAY, D. C.		
LONG, J. W.		
CROCKETT, G		
SHELTON, D.C.		
TUOR, N.R.		
NESTA, S.M.	X	X
COR. CONTROL	X	X
ADMN. RECORD	X	X
WASTE REC. CTR		
TRAFFIC		
PATS/130		
CLASSIFICATION		
UCNI		
UNCLASSIFIED		
CONFIDENTIAL		
SECRET		

AUTHORIZED CLASSIFIER

N/A

Date

IN REPLY TO RFP CC NO:
N/A

ACTION ITEM STATUS

☐ PARTIAL/OPEN

☐ CLOSED

LTR APPROVALS:

ORIG & TYPIST INITIALS
SMN/PLH

Revision 09/04

KAISER•HILL
COMPANY

September 21, 2005 05-RF-00879

Mr. Richard Schassburger
Headquarters Cadre Project Management
DOE, RFPO

TRANSMITTAL OF RESPONSE TO COLORADO DEPARTMENT OF HEALTH AND ENVIRONMENT (CDPHE) COMMENTS OF DECOMMISSIONING CLOSEOUT REPORT FOR THE 881 CLOSURE PROJECT - DWF-098-05

Enclosed are the responses to CDPHE comments on the Final Decommissioning Closeout Report for the 881 Closure Project. Also attached are five color copies of a revised drawing to accompany copied reports.

Transmittal to the CDPHE and the Environmental Protection Agency, in accordance with the Rocky Flats Clean-Up Agreement, is requested. Also, please submit a color copy of the attached drawing.

If you have any questions, please contact Steve Nesta at extension 6386.

Dennis W. Ferrera

Dennis W. Ferrera
Vice President and Project Manager
Remediation, Industrial D&D, and Site Services

SMN/plh

Enclosure:
As Stated

Original and 1 cc - Richard J. Schassburger

cc:
John Rampe, DOE-RFPO

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OCT - 3 2003

ADMIN RECORD

Hill Company, L.L.C.
Flats Environmental Technology Site, 10808 Hwy. 93 Unit B, Golden CO 80403-8200 • 303-966-7000

1/30

SUMMARY OF B881 CLOSEOUT REPORT RESPONSE TO COMMENTS TO CDPHE

1) COMMENT:
Table 3-2 the 2nd item states "no date given". Please change to "October 11, 2001".

RESPONSE:
The date for the RLCR 800 Area Type 1 Cluster Closure is changed to October 11, 2001.

2) COMMENT:
Sections 2.7 & 5 - Please expand these discussions to include the final disposition of all of the facilities included in this Report, not just B881. (830, 864, 885, 887, 890, 881F, 881G, S1, S2, S3, & 881/883 Tunnel) As I recall, S1 was demolished using explosives, and this should be discussed (there was also a lead rim cover on top of the stack that was to be properly disposed of). Also include a discussion of the final disposition of the drains and lines associated with these structures.

RESPONSE:
a) B830 is discussed on page 7 as being demolished on July 21, 2003. B830 slab was well below 4 feet after final grade. Slab was hammered but left in place.
b) B864 was a Type 1, and a closeout report was submitted on 10/18/2002. All demolition debris including slab were disposed as sanitary waste.
c) B885 is discussed on page 7 as being demolished on January 21, 2003. All demolition debris including slab were disposed as sanitary waste.
d) B887 was demolished. Floor of 887 along with the sewer lift station was removed and disposed of. B887 poured walls were removed to 4foot below final grade
e) B890 was removed and rubble was sized and used as backfill for B881 footprint.
f) 881F was demolished and completely removed as part of the B881 Project.
g) 881G was completed removed
h) S1 – concrete stack was demolished using explosives and disposed of as sanitary waste. Hazardous materials associated with the stack were segregated and disposed of properly.
i) S2 – The metal stack was demolished by cutting the base of the stack, setting it on its side and then shearing it so that it could be recycled. The concrete chases were removed and disposed of as sanitary waste
j) Similar to stack S2, S3 stack was removed and recycled. The foundation was removed to >4 feet below grade and the small chase was backfilled (dirt) and remaining void was filled with Flowable fill.
k) B881/883 Tunnel sealed at both ends with cinderblock walls

3) COMMENT:
Figure 5-1 - Please modify this figure or provide another that properly identifies the removed and remaining infrastructure for all of the structures shown on this figure. Show the slabs remaining and removed, as well as the remaining/removed drain lines associated with the floor drains shown, foundation drains, process waste lines, sewer lines, etc. Also, show locations of all areas not backfilled (remaining voids), see Section 2.5.

RESPONSE:
OPWL line on the south side of the building was capped and grout filled. All floor drains in the basement area and sump pits were flow filled. Foundation drains were disrupted as shown in Figure 5-1. The sump and drain piping in the NDT area (NE side) were removed. Transfer piping between B881 and B887 were removed. A new figure is provide depicting remaining & removed structures and lines.

4) COMMENT:
Section 2.5 - Please provide the engineering studies discussed (for all of the remaining non-filled areas), or indicate where they can be found/how to access them.

RESPONSE:
All engineering structural analysis studies were provided as an attachment to the RSOP for Facility Disposition Notification Letter for B881, 881F, and 887, dated April 1, 2004.

5) COMMENT:
Section 2.6.5 - Please provide the radiological results of air monitoring during this demolition event. Or why this is not a concern.

RESPONSE: Attached is the report, "Quantification of Airborne Dust Concentrations Downwind of the Building 881 Demolition," dated September 2005.

6) COMMENT:
Please provide page 6 of Appendix D.

RESPONSE:
Page #6 does not exist. This is a typo.

7) COMMENT:
Either add a section to discuss the disposition of all RCRA Units, or include this discussion in Appendix C.

RESPONSE:
A summary is provided in the attached responses to RCRA comments.

1. COMMENT:

First Paragraph: Rather than two units associated with the 881 Closure Project, there were four units: Unit 887.2 (consisting of 887.2A, 887.2B, 887.2C through 887.2G), 881.3B, plus 881.3A and the unit in B559 covered under Unit 881.3B that, per the Master List, was to be addressed in the B881 Closeout Report. (However, the Master List also indicates a CSR for the B559 unit was submitted to CDPHE on 9/6/01, but CSR acceptance or approval by CDPHE may be outstanding.)

RESPONSE:

Two of the units mentioned above were closed previously under separate cover letters. Unit 881.3A was closed by removal with Permit Modification 01-04 as approved by CDPHE on 11/26/2001. Unit 881.3B supported two additional building operations, one in B559 and the other in B707. Line 741 of the Master List indicates that the unit in B559 was closed by submittal of a Closure Summary Report to CDPHE on 9/6/2001. Line 892 indicates the B707 unit was closed by removal with a submittal date of 3/1/2004. The units which remained pursuant to the scope of the B881 Closure Project are discussed in the facility closeout report.

2. COMMENT:

Table C-1: The table focuses on B881 closure project documentation, e.g RSOP for Component Removal... and a CDD. Rather, the focus should be on the method and dates of closure as documented in RCRs, PE certifications, or correspondence. As a result, dates provided in the table do not readily match closure dates provided in the Master List. Please address. (Discussion of the closure method may warrant an additional column.)

RESPONSE:

Closure methods are discussed in the Major Activities Sections of the Closeout Report. Table C-1 provides a summary of when documents, with RCRA closure information, were submitted. This is consistent with RCRA closures provided within the framework of a RFCA decision document. Consistent with RFCA, when RCRA closure was conducted within this framework, work activities were tied to the baseline for the project and not specific pieces of unit closure.

3. COMMENT:

Row 1: Neither the "Hood Sink" nor its closure is described under Unit 887.2 (Tanks - 2a through 2g) or under Building 881 of the RCRA Master List. Consequently, the closure or CDD date of January 17, 2002 could not be confirmed. Please update or modify the Master List to reflect the hood specifically in addition to the tanks, the closure approach utilized and the actual date of closure under the approved CDD. Then update Appendix C to include the actual date of closure and CDPHE approval, if previously granted.

RESPONSE:

RCRA Unit 887.2 was closed through three partial closure documents. The first Closure Description Document in October 2000 removed the sinks, drains, and vent lines within the B881 facility; specifically rooms 254, 255, 272, and 276. The next CDD, dated April 2001, addressed removal of similar components in the remaining rooms in B881. The third partial closure CDD for 887.2, dated November 2001, addressed hoods, and sinks to be removed. Individual pieces of this unit were removed throughout the closure project and a specific date for each cannot be identified. Individual closure summary reports were submitted to CDPHE for both phase one and phase two closures. The remaining elements of 887.2 are address in the closeout report which also summarizes phase one and two.

4. COMMENT:
Column 2: In Appendix C, if the "Date" is intended to be the units' actual closure dates, please add it to the column heading. If necessary, footnote the table if a CDD etc. approval date is the date provided.

RESPONSE:
The date in the table is not intended to be the closure date, it is the date the commensurate documents were approved by CDPHE for implementation.

5. COMMENT:
Rows 2 &3: The date of February 27, 2002 is the date of the Component Removal RSOP Notification. The date of May 28, 2002 is the date of conditional approval by CDPHE, as indicated. On what dates were the Unit 887.2 Tanks T-183/184/185 and T-802A thru D actually closed. The Master List shows 11/18/04 as the date of the B881Closeout Report, which is not the date of actual closure of the tanks, it is the date of this B881 Closeout Report. Please alleviate the circuitous reporting, e.g. the B881 Closeout Report referencing itself.

RESPONSE:
Documentation does not support the actual date of tank removal but the tanks were removed in the fall of 2004 prior to facility demolition. Under RFCA, closure dates are reflected when the closeout reports are submitted since totality of the work is identified in the baseline scope schedule submitted with the RSOPs.

6. COMMENT:
Row 4: The entry only discusses Unit 881.3B in B881. The Master List includes Unit 881.3B in B559 that, per the entry, is to be addressed in the B881 DD Closeout Report. Please add to Appendix C.

RESPONSE:
See response to comment #1.

7. COMMENT:
Row +: Please add a row and discuss Unit 881.3A, Electrochemical Chlorination (Reactive Cyanide Treatment) Process, Rm. 245 (80.1), in B881.

RESPONSE:
Modification #01-04 to the RCRA Permit dated 11/26/2001 removed the unit from use. Information regarding this process is identified in CDD, dated June 5, 2000.

8. **COMMENT:**
Closure Summary Information for RCRA Unit 881.3B: In the second paragraph of the section, the discussion of Room 267 is consistent with the Master List entry for Unit 881.3B. However, the Master List does not discuss Hoods 3, 4 and 5. Please verify and modify the Master List if necessary.

RESPONSE:
The master list does not address individual components of a unit.

9. COMMENT:

In the second and third bullets please define the two phases. Would it not be appropriate to summarize the closure of the Hood and Sink, and the phased, closures?

RESPONSE:

See response to comment #3 above.

10. **COMMENT:**

Description of Major Closure Activities: Please summarize and relate how the four conditions of the Unit 887.2A through 887.2G RSOP agreement letter from CDPHE, dated May 28, 2002, were addressed.

RESPONSE:

a) The line from valve vault #1 to B887 is identified in the new process waste line closure summary document dated 8/23/2005. The line was RCRA clean through decontamination techniques. Most of the line was ultimately removed, a small portion was left along with valve vault #1.
b) The entire slab from 887 was ultimately removed; not requiring any additional verification.
c) Slab was removed, and soil sampling conducted per the industrial area sample analysis plan did not find contamination.
d) All work control documents were reviewed by CDPHE.

Quantification of Airborne Dust Concentrations Downwind of the Building 881 Demolition

September 2005

EXECUTIVE SUMMARY

On July 17, 2004, Building 881 at the Rocky Flats Environmental Technology Site (RFETS) was demolished using explosives. As expected, the demolition produced a significant but short-lived plume of airborne dust. This study was intended to quantify the airborne dust concentrations from building demolition for two purposes: 1) to improve our knowledge of the short-term atmospheric impact of building demolition using explosives, and 2) to provide information that will be used in future dispersion models of building demolitions using explosives at RFETS.

A monitoring study was implemented to capture and quantify particulate matter from Building 881 demolition. The study employed 12 total suspended particulate (TSP) samplers at fixed locations around the demolition between 216 and 320 meters (m) distance, along with three truck-mounted samplers that were positioned at similar distances "downwind" of the expected plume shortly before demolition. In addition, four optical aerosol monitors positioned on the trucks were used to determine the duration of plume passage. The demolition plume was videotaped against a known reference to allow the vertical extent of the plume to be estimated. Still photos from the demolition were used to determine plume structure and to guide the modeling study of plume dispersion. A portable meteorological data collection system was collocated with one of the TSP samplers to collect the wind parameters needed to model plume dispersion from the demolition. TSP data collected by the sampling array over approximately 30 to 90 minutes, depending on the sampler, were adjusted to estimate peak TSP concentrations during plume passage, as well as peak 15-minute concentrations during demolition, at each of the impacted sampler locations.

The results of the monitoring study showed that plume passage at each of the affected sampling locations, 200 m to 300 m downwind, occurred in less than 15-minutes, with most samplers experiencing elevated concentrations for approximately 6 minutes. A peak 15-minute concentration of approximately 7,000 micrograms per cubic meter ($\mu g/m^3$) TSP was estimated at the most impacted sampling location, with a peak 6-minute concentration of approximately 17,000 $\mu g/m^3$. This estimated peak concentration during demolition represents a 1,300-fold increase in dust concentration compared with pre-demolition levels.

For comparison, researchers at Johns Hopkins Medical Institutions have reported measurements of fine particulate matter (PM_{10}) at four locations around the explosive demolition of a 22-story building. Downwind peak PM_{10} concentrations varied with distance (54,000 to 589 $\mu g/m^3$), exceeding pre-demolition levels for sites 100 m and 1,130 m downwind by 3,000-fold and 20-fold, respectively. Peak PM_{10} concentrations were short-lived; concentrations at most sites returned to background within 15 minutes. A similar pattern was observed for the Building 881 demolition plume.

The dispersion of the demolition dust plume was modeled using the US Environmental Protection Agency Industrial Source Complex Short-Term model (ISCST3), using 15-minute meteorological data from the portable meteorological system. In addition, finer resolution meteorological data from the National Renewal Energy Laboratory wind site, located a few miles northwest of Building 881, were used to construct a hypothetical meteorological data set with more wind variability that was used for additional modeling studies. A sensitivity study of wind direction and initial source size was performed to find the model configuration that produced the best match to measured concentrations at the samplers that were downwind of the demolition. The best-fit results were used to back calculate apparent particulate matter emission rates from the demolition.

The study indicated that average particulate matter emissions during the 15-minutes encompassing demolition were probably in a range between 200 to 2,000 grams per second (g/s). When particle deposition that would have occurred between the demolition itself and the sampling locations is considered, the emission rates at the source were probably somewhat higher, by perhaps as much as 10%, depending on the actual particle size distribution of the demolition dust. It is expected that up to 85% of

8

the emissions may have been in the respirable range (PM_{10}).

TSP concentrations were projected to the minimum fenceline distance (1,800 m) from Building 881 using the range of emission rates estimated for the demolition. Peak 15-minute concentrations at 1,800 m downwind would likely have been in the range of approximately 50 to 1,630 $\mu g/m^3$, with maximum 1-hour concentrations between approximately 25 and 420 $\mu g/m^3$, including background particulate matter from sources other than Building 881 demolition. For a 24-hour average, the expected fenceline concentrations would have been between 13 and 29 $\mu g/m^3$, well below the National and Colorado Ambient Air Quality Standard limitation of 150 $\mu g/m^3$.

For future reference, note that the distribution of particulate matter in the initial source plume modeled was based largely on photographic data. Demolition of Building 881 took place during unstable atmospheric conditions with relatively light winds. It may be assumed that less stable conditions or higher wind speeds would have produced a somewhat different initial plume distribution. The effects that differing meteorological conditions may have on initial plume structure should be taken into account in planning for future explosive demolitions.

9

1.0 INTRODUCTION

On July 17, 2004, Building 881 at the Rocky Flats Environmental Technology Site (RFETS) was demolished using explosives. Building 881, located at the south-central edge of the RFETS Industrial Area (IA), was a reinforced concrete structure encompassing approximately 1.1 million total square feet of surface area (walls, floors, etc.), with most of the levels below grade. The building mass was estimated to be about 30.5 million pounds. The top two floors of the structure were "pancaked" onto the lower levels using 1,327 pounds of exgel dynamite. Most of the exterior surfaces (roof, south walls, etc.) were covered in fencing and geotextile to minimize projectiles and mitigate dust.

As expected, the demolition produced a significant but short-lived plume of airborne dust. This study was intended to quantify the airborne dust concentrations at known downwind distances that resulted from building demolition for two purposes: 1) to improve our knowledge of the short-term atmospheric impact of building demolition using explosives, and 2) to provide information that will be used in future dispersion models of building demolitions using explosives at RFETS.

1.1 Background

The Building 881 was used as an enriched uranium component manufacturing facility from 1953 to 1966, when stainless steel machining became the principle building activity. Radiological contamination within the facility was remediated prior to demolition; the structure was classified as unrestricted release (less than 200 picocuries per 100 square centimeters [pCi/100 cm^2])[1] at the time of demolition. Therefore, though radiological operations once occurred within the facility, there was no significant radiological emissions potential associated with Building 881 demolition. Building 881 is shown in Figure 1-1.

Prior to the demolition, atmospheric dispersion modeling was performed to assess the potential short-term impacts of Building 881 demolition on air quality. The demolition was modeled using the EPA Industrial Source Complex Short-Term (ISCST3) model, incorporating information from several papers published by researchers at Johns Hopkins Medical Institutions that examined air impacts from building demolitions using explosives in Baltimore, MD. Johns Hopkins researchers reported measurements of fine particulate matter (PM_{10}) at four locations around the demolition of a 22-story building (Beck, et al., 2003). Downwind peak PM_{10} concentrations varied with distance (54,000 to 589 micrograms per cubic meter [$\mu g/m^3$]), exceeding pre-demolition levels for sites 100 meters (m) and 1,130 m downwind by 3,000-fold and 20-fold, respectively. Peak PM_{10} concentrations were short-lived; concentrations at most sites returned to background within 15 minutes. A similar pattern was observed for the Building 881 demolition plume.

The original Building 881 demolition model results were thought to be overly conservative, based on several simplifying assumptions that were made. Through the study reported here, future modeling of RFETS building demolitions are expected to improve in their predictive power based on knowledge gained of the plume height, plume density (airborne dust concentration at known distances), plume structure, plume dispersion rate, and plume duration.

[1] Unrestricted release as defined in the RSOP for Facility Disposition and DOE Order 5400.5

10

1.2 Study Goals

The goals of the study were to:

- Measure total suspended particulate (TSP) concentrations at known distances from the source for known time intervals;
- Measure PM_{10} concentrations at known distances from the source for known time intervals;
- Estimate plume height based on visual observation against a known reference;
- Estimate plume dispersion based on resulting concentration data, plots of time-integrated aerosol monitor data, and analysis of meteorological data;
- Estimate plume duration based on observational and aerosol monitor data;
- Capture meteorological data concurrently with air sampling to facilitate modeling of the emissions source; and
- Develop plume height factors and TSP emission factors for future RFETS building demolitions using explosives, based on the resulting data.

Figure 1-1. Aerial View of Building 881 from the South-Southwest.

2.0 MONITORING STUDY DESIGN AND IMPLEMENTATION

Building 881 was demolished on July 17, 2004. Explosive charges were used to weaken the upper walls of the structure, which was then collapsed onto the lower floors. Demolition commenced at approximately 10:47 am.

2.1 Monitoring Study Design

The study design is documented in more detail in the *Sampling and Analysis Plan* for this project (URS Group, 2004).

2.1.1 Boundary Definition, Spatial

To capture the plume from the demolition, 12 TSP samplers were arrayed along 30-degree radials surrounding the Building 881 demolition, subject to the limitations of topography, infrastructure, and access postings. Distances from Building 881 ranged from 216.2 m to 320.7 m, just outside the 750-foot exclusion zone established to protect personnel. Samplers were placed uniformly around Building 881 because daytime winds at RFETS in mid-July are often light and variable. As a result, wind direction for the event period was not predictable based on historical meteorological data, so attempting a predictive "downwind only" array of fixed locations could not guarantee plume capture.

In addition to the fixed sampling array, three trucks were outfitted with a TSP sampler and PM_{10} optical aerosol monitor each. One truck also contained a collocated TSP optical aerosol monitor. Shortly prior to the demolition, based on observed wind flow, the three trucks were arrayed in the southwest quadrant at distances ranging from 283.1 to 365.9 m from Building 881, as close as access would allow to the 750-m exclusion boundary. Sample collection points were between 1 and 2 m above ground.

Locations of all samplers and meteorological measurements were recorded using global positioning system (GPS) technology. Sampling locations are shown in Figure 2-1.

2.1.2 Boundary Definition, Temporal

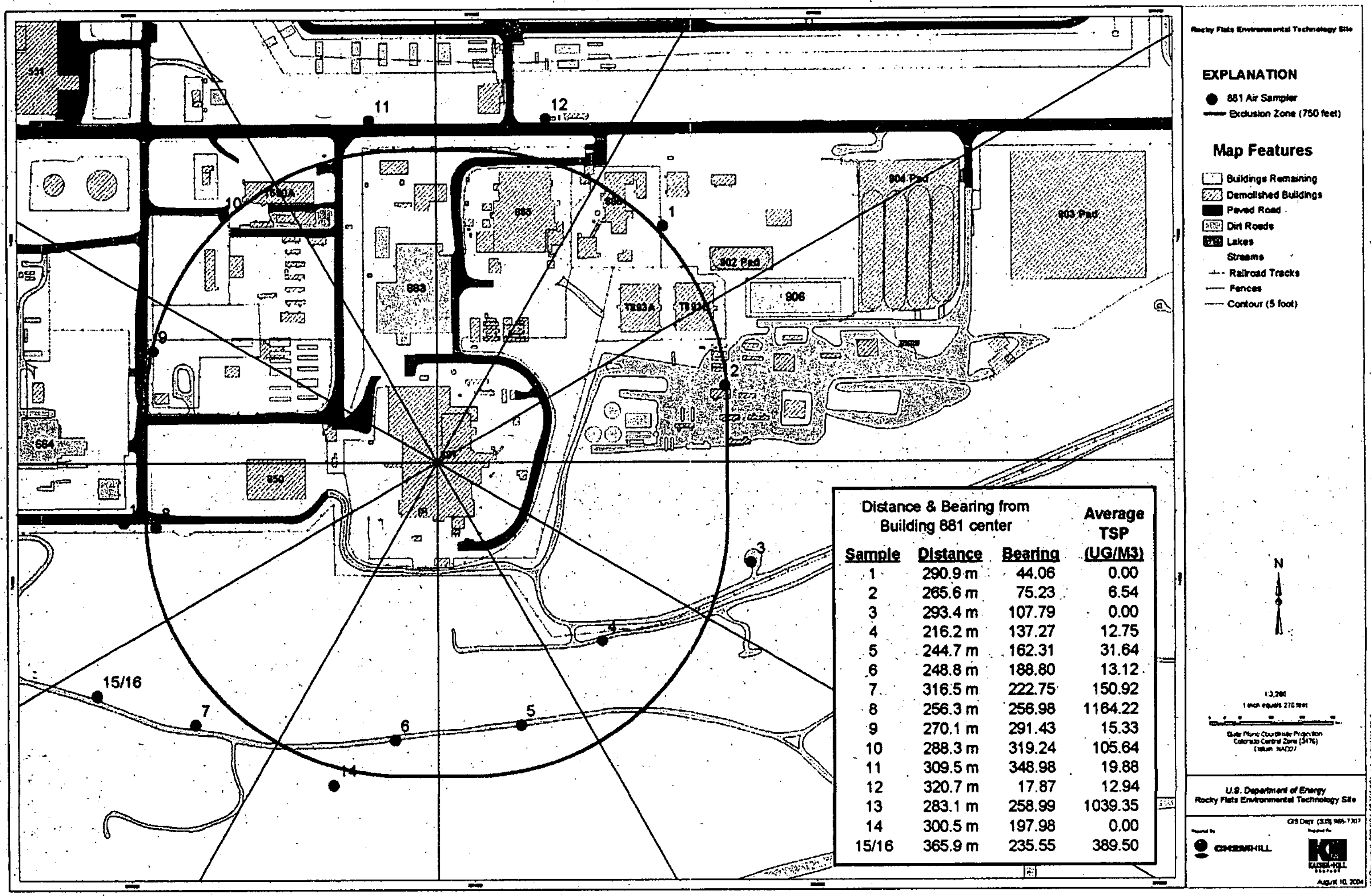
The sampling periods for the TSP samplers ranged from 32 minutes to 89 minutes, depending on location. The shorter periods were from the truck-mounted samplers, which were switched on shortly before demolition and switched off after the plume had dispersed. The PM_{10} and TSP aerosol monitors operated continuously through the demolition period and recorded time-integrated data.

2.1.3 Description of Sampling Architecture

The TSP sample pump and a block diagram of the sample filter assembly (snorkel) are illustrated in Figures 2-2 and 2-3. The sample media is protected from weather by a bell-shaped shell. The sample media and the shell are oriented downward to prevent precipitation from impacting the samples. Sample filters were loaded into and unloaded from filter holders in the laboratory and transported in their holders to ensure filter integrity. Filters, filter holders, and sample pumps were all individually numbered to ensure traceability and chain of custody.

The R&P Dustscan Scout model 3020 aerosol monitor is illustrated in Figure 2-4. The Scout 3020 is a real-time aerosol monitor that uses forward scattering of light to quantify particle counts per unit time. Size-partitioning inlets allow for measurement of PM_{10}. Data can be downloaded to Windows-based systems to allow for processing and plotting of results.

12



Sample	Distance	Bearing	Average TSP (UG/M3)
1	290.9 m	44.06	0.00
2	265.6 m	75.23	6.54
3	293.4 m	107.79	0.00
4	216.2 m	137.27	12.75
5	244.7 m	162.31	31.64
6	248.8 m	188.80	13.12
7	316.5 m	222.75	150.92
8	256.3 m	256.98	1164.22
9	270.1 m	291.43	15.33
10	288.3 m	319.24	105.64
11	309.5 m	348.98	19.88
12	320.7 m	17.87	12.94
13	283.1 m	258.99	1039.35
14	300.5 m	197.98	0.00
15/16	365.9 m	235.55	389.50

Distance & Bearing from Building 881 center

13

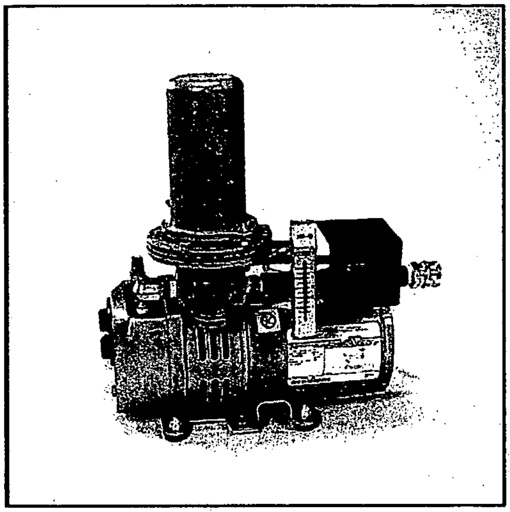


Figure 2-2. Hi-Q VS23-1023CV

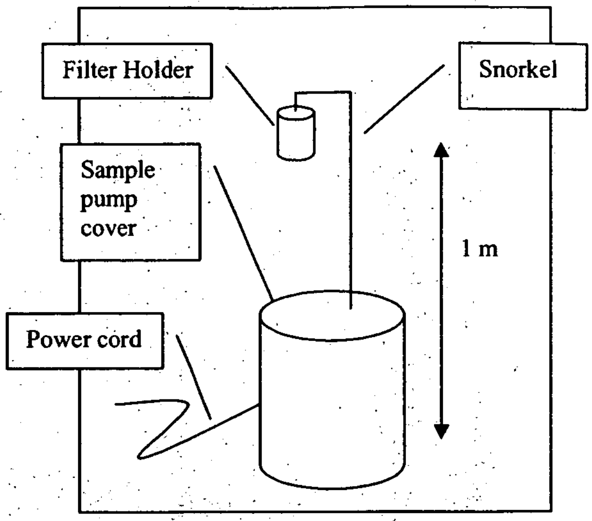


Figure 2-3. Simplified Diagram

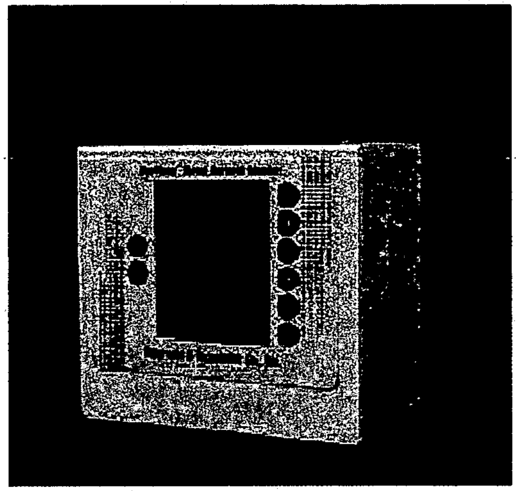


Figure 2-4. Aerosol Monitor

14

2.2 Implementation

2.2.1 Number of Samples and Schedule

- An array of 12 medium-volume TSP air samplers were arrayed along 30 degree radials to collect ambient air samples during the demolition (12 x 30° = 360°).
- Twelve *Hi-Q* model VS23-1023CV medium-volume sample pumps, powered by portable gasoline-fueled generators, were used for TSP sampling.
- TSP sample media consisted of tared 47 millimeter (mm) glass fiber filters.
- Four R&P Dustscan Scout model 3020 aerosol monitors were deployed to provide semi-quantitative, time-integrated plots of plume density and duration. Three units used PM_{10} inlets (one per truck) and a fourth unit sampled TSP to provide a calibration reference.
- Three trucks were outfitted with a TSP air sampler and a PM_{10} aerosol monitor each, and were deployed into the plume path to characterize downwind emissions.

2.2.2 Sample Preparation and Analysis

Sample filters were marked with unique, sequential identification numbers to correspond with sample location, sample date/time, and Report Identification Number (RIN). Filters were conditioned for a minimum of 24 hours in a desiccator at laboratory temperature in the Stoller Low Level Laboratory (LLL) of Building T130A. All gravimetric analyses were performed to a constant result, in accordance with Stoller LLL gravimetric analysis procedure. Once tared, filters were installed into filter holders and assembled into the provided sample carrier by LLL staff to await pickup by field staff.

Exposed samplers were returned to the LLL in their filter holders. Samples were recovered from their filter holders and reconditioned for a minimum of 24 hours in a desiccator at laboratory temperature. Once conditioned, final weight was determined to a constant result. Results were reported in accordance with the applicable Analytical Services Division task order requirements.

2.2.3 Meteorological Monitoring

To support the development of emission factors for use in atmospheric dispersion modeling from the data collected, meteorological monitoring was performed in the vicinity of the demolition. A portable 2-meter meteorological station was installed by the field sampling team and recorded temperature, wind direction, wind speed, and standard deviation of horizontal wind direction (sigma theta) as 15-minute averages.

2.3 Quality Assurance/Quality Control

A field QA/QC program was followed to ensure that data quality objectives are met. Sample collection errors were controlled using standard collection methods, field documentation, and chain-of-custody logs. Field log sheets were used to record sample identification, sample times, sample flow rates, sample anomalies, and sample condition. Each filter was uniquely identified on the filter itself using a sequential identification paradigm.

The project name, sample RIN, analytical method, name of sampling technician(s), sample location, and date and time of collection were recorded on sample chain of custody forms. The Site Analytical Services Division (ASD) followed established Site procedures in tracking samples to and data from the analytical laboratories and in providing data quality assurance through data validation/verification processes.

Three trip blanks were prepared and subjected to gravimetric analysis. The trip blanks accompanied samples to and from the field. Trip blank results were used to confirm the quality of the gravimetric data population. Equipment and configuration constraints precluded duplicate sampling.

15

All quality assurance documents generated as a result of this monitoring project are being maintained in accordance with the Site standards, as documented in the *Site Documents Requirements Manual* and *Records Management Guidance for Records Sources*.

16

3.0 MONITORING STUDY RESULTS

This section describes the results of the monitoring study of Building 881 demolition.

3.1 Overview

Demolition occurred at approximately 10:47 am on July 17, 2004. The detonation included a sequence of 16 sequenced shots to weaken the structure, followed by a final shot to drop the roof. Total duration was around 10 seconds.

Photographs were taken from the southwest of the building at a distance of approximately 900 m. The photographs provide a record of the evolution of the plume and its movement. In addition, a video of the event was taken from the south using a yardstick at a known distance from the camera and from Building 881 to allow calculation of the vertical extent of the plume.

Figure 3-1 shows the beginning of building collapse following detonation (note the bulging at the bottom of the geotextile fabric with which the building was wrapped). It can be seen that the explosive charges themselves caused only minor dust generation. Figure 3-2 shows the beginning of a dust cloud associated with the collapse of the building structure.

Figure 3-1. Initiation of Building 881 Collapse

Figure 3-2. Initiation of Plume

Figure 3-3 shows the dust cloud beginning to spread both out and up from the building location. The following figure, Figure 3-4, shows the growth of the dust cloud within the first few seconds following building collapse. Some dispersion is evident to the west, on the left side of the picture, as the dust cloud begins to be influenced by the wind.

Figure 3-5 shows the plume moving downwind from the Building 881 location. Some stratification of the plume is apparent in this photograph, with the lower portions of the plume showing greater dust density than the middle or upper portions. The plume structure evident in this picture was used to determine the best way to model the event (see Section 4.0). Figure 3-5 also shows the locations of two of the truck-mounted sampling units—the front portion of one truck (location 14) can be seen at the far right edge of the picture, near the bottom. The red truck at location 15/16 can be seen at the far left edge of the picture, also near the bottom. Locations 13 and 8 are just off the picture to the left along the ridgeline.

Figure 3-6 shows a later view of the plume, which has continued to disperse to the west. Trucks at locations 14 and 15/16 can also be seen in this picture. The truck-mounted sampler at location 13 is at the western edge of the plume, at the approximate location of the tree that can be seen near the top of the ridge. Note the plume movement that has occurred between Figure 3-5 and Figure 3-6; the trees evident near the center of the plume in Figure 3-6 are the same trees that can be seen at the western edge of the plume in the earlier photograph shown in Figure 3-5. Note also that the plume has largely dispersed beyond the location of Building 881 itself, located at the far right hand edge of the plume in this picture.

18

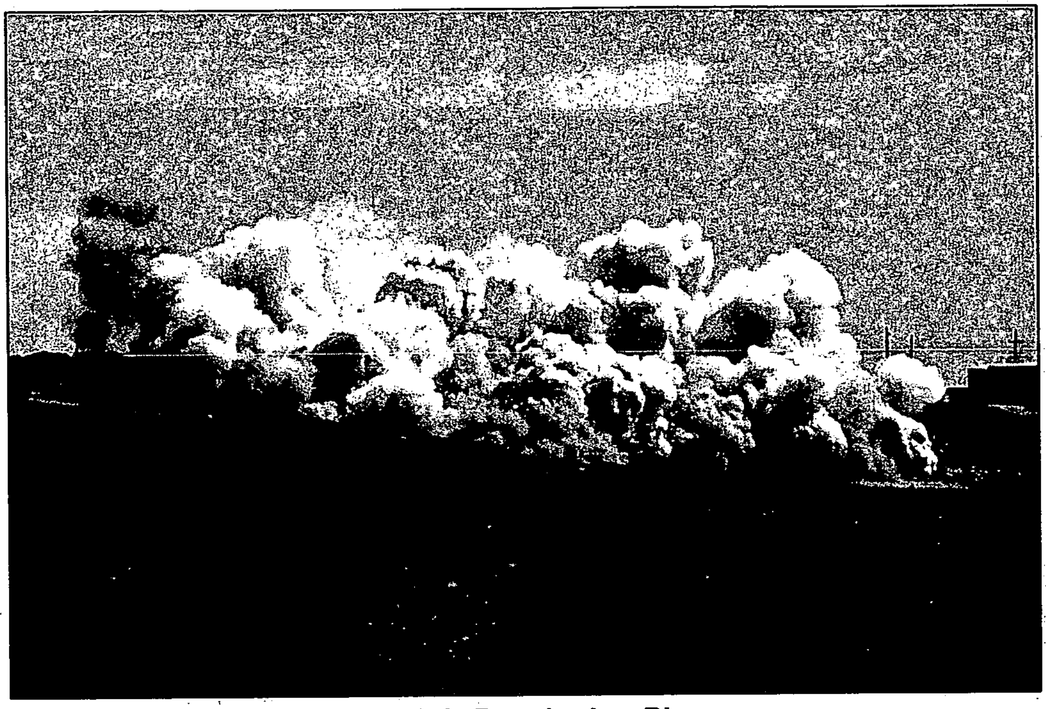


Figure 3-3. Developing Plume

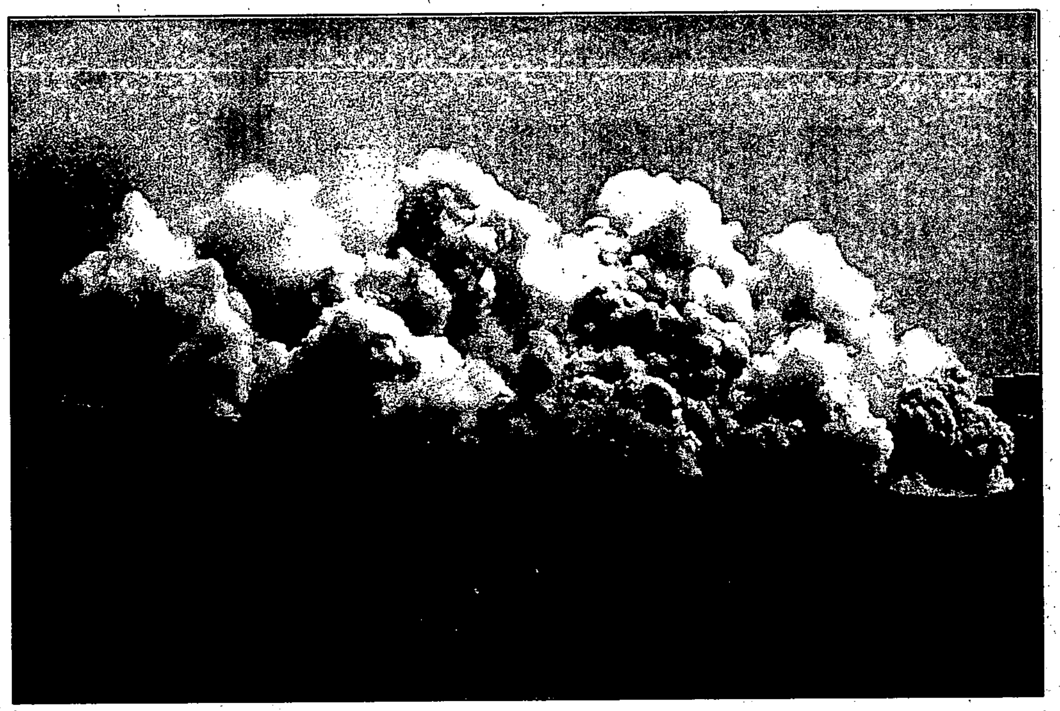


Figure 3-4. Plume Beginning to be Affected by Wind

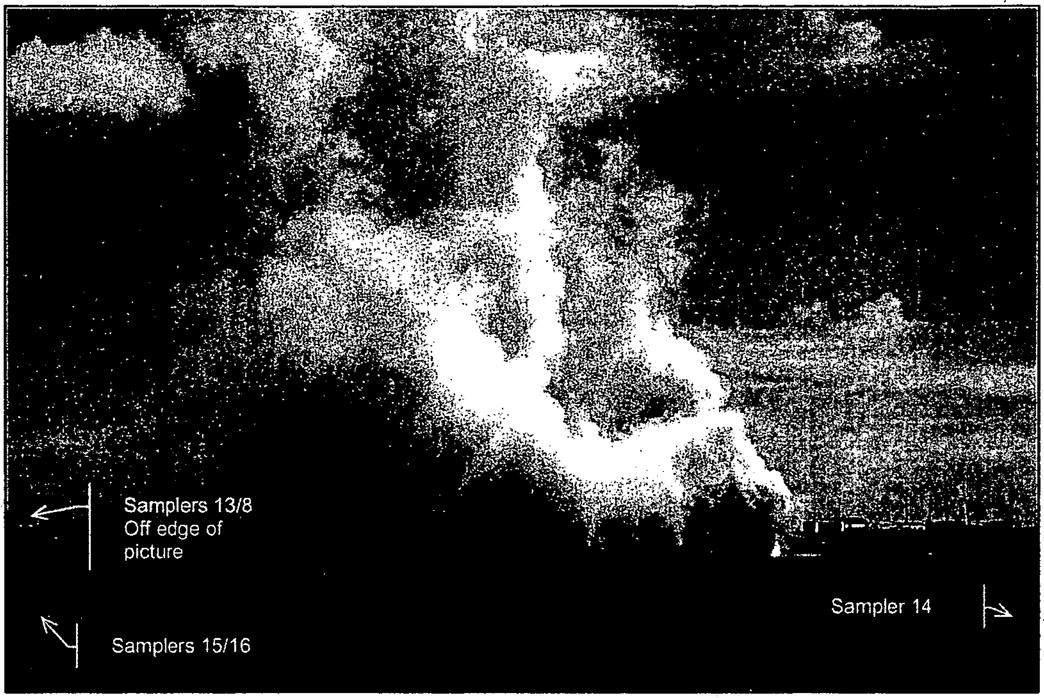


Figure 3-5. Stratified Plume Moving West

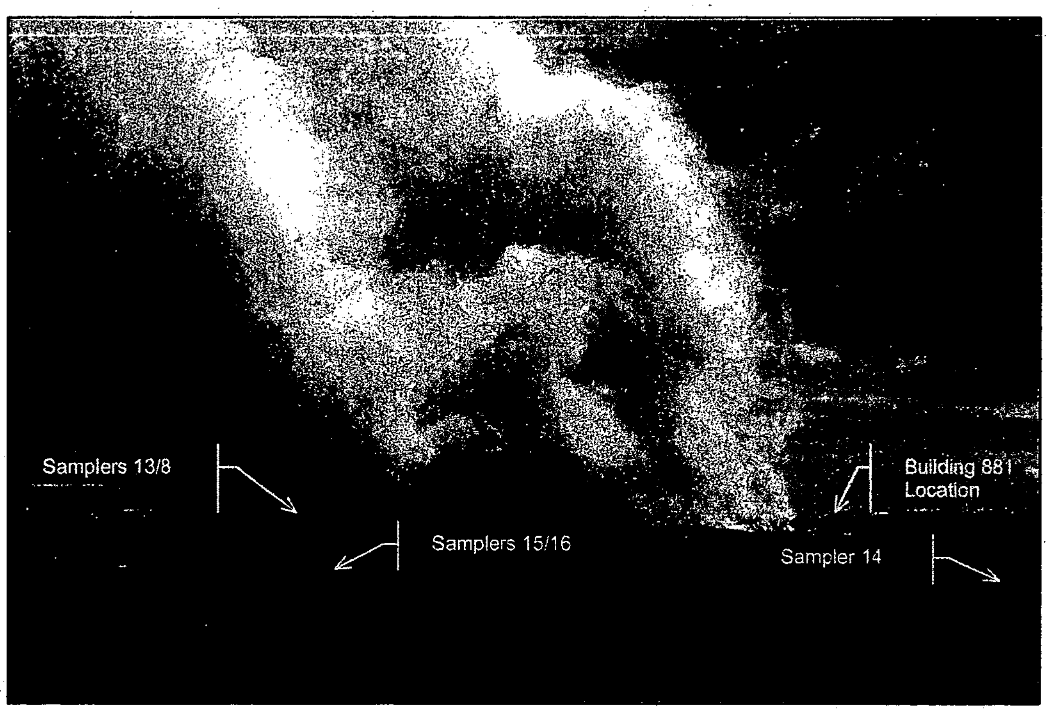


Figure 3-6. Dispersing Plume Impacting Samplers 8 and 13

20

The photographic evidence shows several things that help to put the resulting measurement data in context:

- The dust cloud produced by the explosive demolition of Building 881 was largely derived from the collapse of the building structure itself, and the resulting air displacement, rather than from the explosives used for demolition. The vertical extent of the plume was thus determined more by the energy of the collapsing building mass, combined with meteorological conditions existing at the time of collapse, than by the quantity of explosives used.
- The resulting plume spread out as well as up, producing a broad, irregularly shaped "source" from which subsequent dispersion occurred.
- Stratification of mass is apparent within the plume. The video evidence allowed a calculation of 1,270 feet to the top of the plume (atmospheric conditions during demolition were unstable, which would have encouraged vertical growth of the plume). Based on that dimension and on Figure 3-5, it was estimated that approximately 60% of the mass was contained in the lower 300 feet of the plume, an additional 30% between 300 and 700 feet above ground, and the final 10% between 700 feet and the plume top. This information was later used in modeling the event to calculate the mass emission rate associated with the demolition.
- Samplers at locations 13 and 8 were well within the central portion of the plume. These locations recorded the highest concentrations of any of the sampler locations, as expected from the photographic evidence. Samplers located somewhat northeast and southeast of these locations also sampled the edges of the plume, while most other samplers were clearly upwind.
- Between the succession of photographs, the video recording, and data from the optical aerosol monitors, it was apparent that plume passage occurred quickly, with a return to background concentrations within a few minutes at most locations.

3.2 Gravimetric Analyses

Table 3-1 shows the results of the gravimetric analyses.

As can be seen, locations 8 and 13, which were located due west of the southern portions of Building 881, were the most impacted locations. The concurrent meteorological data, which were collected from a location close to sampler 8, showed an average wind direction for the 15-minute period encompassing demolition as from the east (approximately 93 degrees) at 3.14 meters per second. This provides good confirmation that samplers 8 and 13 were near the plume centerline.

Samplers at locations 7, 10, and 15 appear to have sampled portions of the plume further from the centerline. Most of the other samplers recorded only low levels of particulate matter, characteristic of background concentrations.

Sampler 9 presents something of a puzzle. Sampler 9 was located between samplers 8 and 10, both of which show evidence of having been within the plume. Sampler 9 recorded only low particulate matter concentrations, however, at concentrations similar to the upwind locations. There are several reasons why this may have occurred, including some undetected malfunction of the unit. Sampler 9 was located along a road to the west of a parking area that is frequently used to stage trucks and trailers. If the lot contained a number of trucks and trailers during demolition, they could have shielded sampler 9 from the plume, or perturbed the air flow such that the plume broke around the location. Also note the lack of homogeneity in the plume density in Figures 3-3 through 3-6; sampler 9 could also have just been in a gap in the plume.

Table 3-1. Gravimetric Results for Building 881 Demolition

Filter ID/Location	Time On/Time Off (July 17, 2004 am)	Elapsed Time	Sample Volume (m^3)	Net Weight (mg/filter)	Average TSP ($\mu g/m^3$)
1	9:56 11:14	1:18	14.27	-2.1 (no net gain)	0.00
2	10:00 11:17	1:17	15.29	0.1	6.54
3	10:04 11:22	1:18	13.86	-0.1 (no net gain)	0.00
4	10:07 11:26	1:19	15.68	0.2	12.75
5	9:56 11:11	1:15	12.64	0.4	31.64
6	9:55 11:13	1:18	15.24	0.2	13.12
7	9:53 11:15	1:22	14.58	2.2	150.92
8	9:50 11:19	1:29	15.46	18.0	1164.22
9	9:54 11:13	1:19	13.05	0.2	15.33
10	9:58 11:16	1:18	13.25	1.4	105.64[a]
11	10:01 11:19	1:18	15.09	0.3	19.88
12	10:04 11:23	1:19	15.46	0.2	12.94
13	10:13 10:58	0:45	8.56	8.9	1039.35
14	10:26 10:58	0:32	6.20	-0.1 (no net gain)	0.00
15	10:17 10:55	0:38	6.93	2.7	189.50
16	Trip blank	NA	NA	-0.1 (no net gain)	NA
17	Trip blank	NA	NA	0.0 (no net gain)	NA
18	Trip blank	NA	NA	-2.3 (no net gain)	NA

[a] Filter was black; may have been impacted by diesel smoke.

Notes:

m^3 = cubic meters
mg = milligrams
$\mu g/m^3$ = micrograms per cubic meter

22

The concentrations shown in Table 3-1 are average particulate matter concentrations for the duration of sampling at each location. Three of the optical aerosol monitors, a TSP sampler at location 16 (collocated with location 15) and PM_{10} samplers at locations 13 and 15, recorded plume passage. The detailed record at these locations showed that elevated concentrations occurred for approximately 6 minutes, with peak concentrations occurring for much shorter periods of time (the aerosol monitoring data are discussed further in Section 3.3). "Background" particulate matter concentrations during demolition were calculated as the median concentration from the "upwind" samplers. Assuming that each of the samplers in the plume recorded background concentrations for all but 6 minutes of the sampling period allowed an estimate of peak 6-minute concentrations and 15-minute average concentrations for the critical 15-minute period containing the demolition event. The resulting peak concentration estimates are shown in Table 3-2.

Table 3-2. Estimated Peak TSP Concentrations at Sampling Locations

Location	Peak 6-Minute TSP Concentration (μg/m³)	Peak 15-minute Average TSP Concentration (μg/m³)
7	1,900	768
8	17,092	6,844
10	1,219	495
13	7,712	3,092
15	2,398	967

Notes:

μg/m³ = micrograms per cubic meter

3.3 Aerosol Monitor Data

Figure 3-7 shows the results from the optical aerosol monitors. Location 13 was due east of the southern portion of Building 881 and received the initial plume contact. The winds then shifted the plume in a somewhat more southerly direction, impacting locations 15 and 16 (collocated). (All of the optical aerosol monitors were truck mounted.)

The aerosol monitors employed for this exercise estimate particle concentrations based on forward scattering of light by the particles. Because larger particles do not scatter light as effectively as smaller particles, the actual concentrations of PM_{10} and especially TSP are likely to be underestimated. Consequently, the monitoring study was planned so that optical aerosol monitors were collocated with TSP samplers so that the concentrations recorded by the aerosol monitors could be "calibrated" against the gravimetric data.

Unfortunately, examination of Figure 3-7 shows that the tops of the concentration peaks recorded by the aerosol monitors were "clipped" due to saturation of the optical detector or because the concentrations and particle properties encountered during demolition challenged the physical limits of the signal processor. As a result, the optical aerosol monitoring data were used primarily to record the extent and duration of the plume from Building 881 demolition.

23

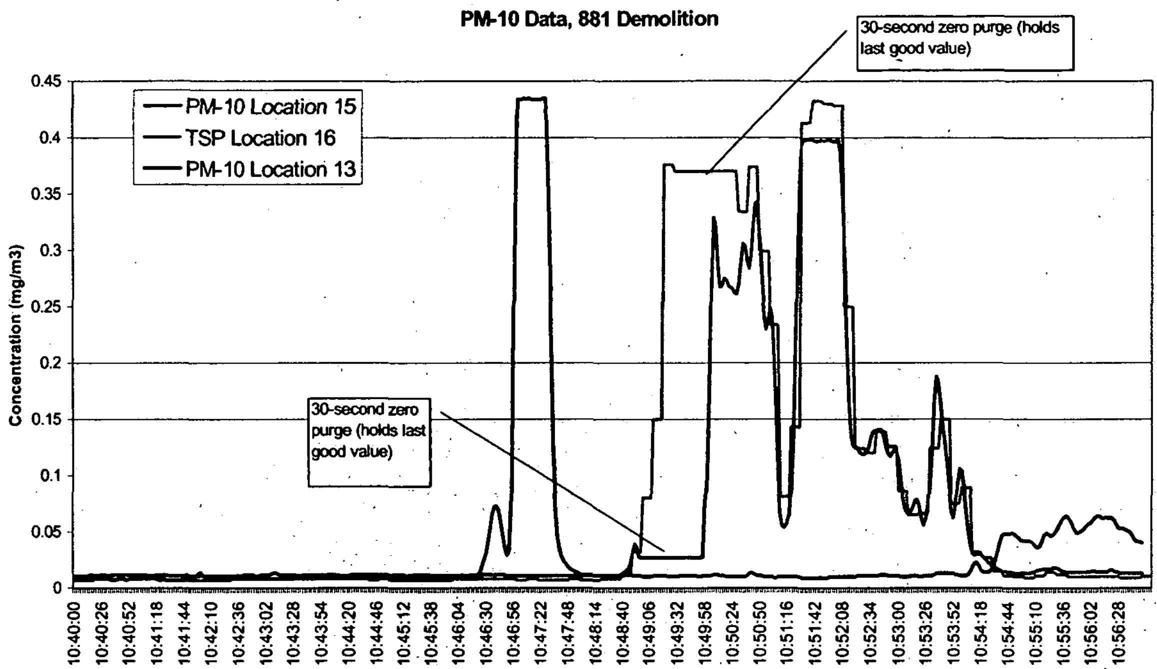


Figure 3-7. Optical Aerosol Monitoring Data

3.4 Discussion

Several studies that measured particulate matter concentrations around building demolition operations were reviewed. The most relevant studies are documented in several papers published by researchers from Johns Hopkins Medial Institutions that looked at air impacts from explosive demolition of a building in the Baltimore, MD, area. A relevant study was published in the Journal of the Air and Waste Management Association (AWMA) in October 2003 (*Impact of a Building Implosion on Airborne Particulate Matter in an Urban Community*. Beck, et al., 2003.) Researchers reported measurements of PM_{10} at four locations around the demolition of a 22-story building. Downwind peak PM_{10} concentrations varied with distance (54,000 to 589 $\mu g/m^3$), exceeding pre-demolition levels for sites 100 m and 1,130 m downwind by 3,000-fold and 20-fold, respectively. Peak PM_{10} concentrations were short-lived; most sites returned to background within 15 minutes.

These results are generally consistent with the measured impacts from Building 881 demolition. Maximum TSP concentrations at 200 m to 300 m downwind from Building 881 were estimated to be approximately 17,000 $\mu g/m^3$ for the 6-minute passage of the demolition plume, with 15-minute average concentrations at approximately 7,000 $\mu g/m^3$. PM_{10} concentrations would likely have been slightly lower. Estimated peak 6-minute TSP concentrations from Building 881 demolition represent a 1,300-fold increase over pre-demolition particulate matter concentrations at the sampler locations, 200 m to 300 m downwind. As demonstrated in the Baltimore, MD, demolition, plume passage occurred in less than 15 minutes.

24

4.0 MODELING STUDY

One of the objectives of the plume study was to use dispersion modeling to "back calculate" emissions from the demolition of Building 881. The modeling study is described below.

4.1 Modeling Methods

The Industrial Source Complex Short-Term (ISCT3) model was used to estimate airborne particulate matter for comparison with measured concentration data. Based on the observed shape and extent of the plume (see Figure 3-6), the demolition was modeled as three "stacked" volume sources in ISCST3. The lowest volume source extended from groundlevel to 300 feet, the second was assumed to extend from 300 feet above ground to 700 feet, and the highest volume source extended from 700 feet to the observed top of the demolition plume at 1,270 feet. Modeling assumed flat terrain, although the actual terrain surrounding Building 881 is somewhat rolling.

The sources were modeled with a "unit" emission rate—that is, a total emission rate of 1 gram per second from all three sources. Based on the observed plume, 60% of this emission rate was assigned to the lowest volume source, 30% to the middle source, and 10% to the upper level source. The release height and initial vertical extent of each of the three sources was based on guidance provided in the US Environmental Protection Agency's (EPA's) *User's Guide for the Industrial Source Complex Dispersion Models*, Volume 1, Section 3 (EPA, 1995). Results from the unit emission rate modeling were combined with measured concentrations determined from gravimetric data on a receptor-by-receptor basis and an apparent emission rate for the demolition event was calculated at each receptor. The receptors used for modeling matched the distance and bearing of each sampling location, measured from the center of Building 881.

Initial modeling was performed using the critical 15-minute average meteorological data as recorded by the portable station located near sampler location 8 (i.e., between 10:45 and 11:00 am on July 17, 2004). Although ISCST3 assumes a 1-hour time step (therefore, the shortest averaging period that can be directly modeled is 1 hour), information regarding the technical formulation of the ISCST3 dispersion equations suggests that the plume spread parameters used by ISCST3 are actually representative of 10-15 minute averaging periods. Therefore, we have modeled using ISCST3 with 15-minute meteorological data and taken the resulting "1-hour" concentrations to be characteristic of 15-minute averages as well.

Data for the critical 15-minute period encompassing demolition showed an average wind direction of 93.6 degrees (from slightly south of east) and a wind speed of 3.14 meters per second. Temperature and standard deviation of horizontal wind direction were also measured. Stability class was calculated from the measured data (wind speed and wind direction standard deviation) using an algorithm employed by EPA's Meteorological Processor for Regulatory Models (MPRM) (EPA, 1996).

Because demolition emissions and dispersion actually occurred over a period shorter than 15 minutes, based on photographic and optical aerosol monitor evidence, wind direction was varied over a small range to try to produce a better fit to the gravimetric data. Wind directions were varied between 88 and 100 degrees.

The source "footprint" was also varied to improve the correspondence between concentration predictions and the gravimetric data. One problem with using a single 15-minute period for modeling is that the plume spread is likely to be somewhat underestimated since the relatively light wind speeds that occurred during demolition would normally have been associated with somewhat variable wind directions. In this case, the "best" fit was determined by calculating the difference between the apparent emission rate calculated for each individual receptor and the ensemble average emission rate calculated for the group of receptor locations that sampled the plume (locations 7, 8, 10, 13, and 15), where the ensemble average

25

was represented by the median emission rate calculated for this group. The source footprint was represented by an initial lateral extent parameter, which was also calculated according to guidance in the ISCST3 User's Guide (EPA, 1995), Section 3. Initial lateral extents for the stacked volume sources varied from 20 m to 70 m. (At an initial lateral extent of 70 m, the edge of the total source area would extend slightly beyond the closest of the impacted sampling locations (to 301 m), so a larger source area was not considered credible.)

To further compensate for the "single wind direction" problem inherent in using only one meteorological period for modeling, a somewhat hypothetical meteorological data set was constructed with varying wind directions. The National Renewable Energy Laboratory (NREL) operates a meteorological tower at the northeast corner of the RFETS Buffer Zone, only a few miles from Building 881. Raw data from the 2-m level were downloaded for the critical 15-minute period (10:45 to 11:00 am, July 17, 2004); the data are 1-minute averages. Wind speeds and directions for each 1-minute interval were changed to more closely match the 15-minute average data from the portable meteorological tower employed in the Building 881 plume study by adding the same number of degrees and meters per second to each 1-minute data point until the mean wind speed and direction matched the RFETS data. Following the initial sensitivity analyses for wind direction with the 15-minute RFETS data, the NREL-based data set was readjusted to match the best-fit wind angle (approximately 89.5 degrees).

This "adjusted" data set was also used as input to ISCST3 and period averages were calculated at each receptor for the 13-minute period from 10:47 am to 11:00 am, July 17, matching the demolition and plume dispersion period. Source "footprints" were again varied between 20 m and 70 m to produce "best fit" results. Calculated emission rates were scaled up slightly to account for the difference between the 1-minute resolution of the meteorological data and the assumed 10-minute resolution of the dispersion parameters used by ISCST3.

4.2 Results

The results of the modeling exercise are shown in Table 4-1. Apparent emission rates were calculated based on estimated peak 15-minute concentrations from demolition, as shown in Table 3-2, rather than on the measured concentrations for the duration of sampling at each location.

Results are presented for modeling using only the critical 15-minute average meteorological data from the RFETS portable station and also for modeling using the NREL adjusted data. The best fit over all samplers occurred, for both meteorological data sets, at the largest initial lateral extent used (70 m). The range of predicted emission rates from individual sampling locations modeled (7, 8, 10, 13, 15), and the median and average emission rates, are shown in Table 4-1 for the 70-m initial lateral extent simulations.

Table 4-1. Modeling Study Results Building 881 Demolition

Meteorological Data Set	Minimum Calculated Emission Rate (g/s)	Maximum Calculated Emission Rate (g/s)	Average Calculated Emission Rate (g/s)	Median Calculated Emission Rate (g/s)
Average conditions from 10:45 to 11:00 am July 17, 2004	685	1,683	1,162	993
NREL-adjusted data set	214	1,927	801	448

Note: Rates shown represent demolition emissions as grams per second (g/s) for 15-minute period. Actual peak emission rates during demolition would be higher.

4.3 Discussion

The results shown in Table 4-1 indicate that particulate matter emission rates from Building 881 demolition averaged between 200 and 2,000 grams per second (g/s) for the 15-minute period during which demolition occurred. Peak emission rates from the actual demolition event would have been somewhat higher; elevated concentrations occurred for approximately 6 minutes based on optical aerosol monitor data. Previously determined demolition particle size distributions indicate that 85% of emissions or less were probably respirable (PM_{10}) although, as a conservative assumption, it may be assumed that all particles are respirable.

These calculated emission rates do not account for any particulate matter that may have fallen out of the plume and been deposited on the ground or other surfaces between the sampler locations and Building 881. The size and density of particles emitted from demolition have been previously researched for Building 776/777 demolition (conventional demolition). The bounding particle assumptions derived for Building 776/777 can be used to define the probable range of plume depletion that would be expected at various distances downwind. Modeling performed during the planning phase of Building 881 demolition indicated that concentrations at a downwind distance of 200 m (approximately the distance to the closest sampler used in this monitoring program) would be 2% to 8% less than if no deposition occurred, depending on the size and density of the actual resulting particles. This means that the emission rates shown in Table 4-1 probably underestimate actual emission rates from Building 881 demolition by up to 8% or slightly more, since the plume centerline samplers were slightly further downwind than the planning modeling assumed.

The best-fit simulations for both the RFETS 15-minute meteorological data and for the NREL-adjusted data were used to project TSP concentrations to the minimum fenceline distance (1,800 m) from Building 881 using the range of emission rates shown in Table 4-1 and considering deposition effects (fenceline distance from *Site Safety Analysis Report*). The results indicate that peak 15-minute concentrations at 1,800 m downwind would likely have been in the range of approximately 50 to 1,630 $\mu g/m^3$, with maximum 1-hour concentrations between 25 and 420 $\mu g/m^3$, including background particulate matter from sources other than Building 881 demolition. For a 24-hour average, the expected fenceline concentrations would have been between 13 and 29 $\mu g/m^3$, well below the National and Colorado Ambient Air Quality Standard limitation of 150 $\mu g/m^3$.

The distribution of particulate matter in the initial source plume was based largely on photographic data. Demolition of Building 881 took place during unstable atmospheric conditions with relatively light winds. It may be assumed that less stable conditions or higher wind speeds would have produced a somewhat different initial plume distribution. The effects that differing meteorological conditions may have on initial plume structure should be taken into account in planning for future explosive demolitions.

5.0 REFERENCES

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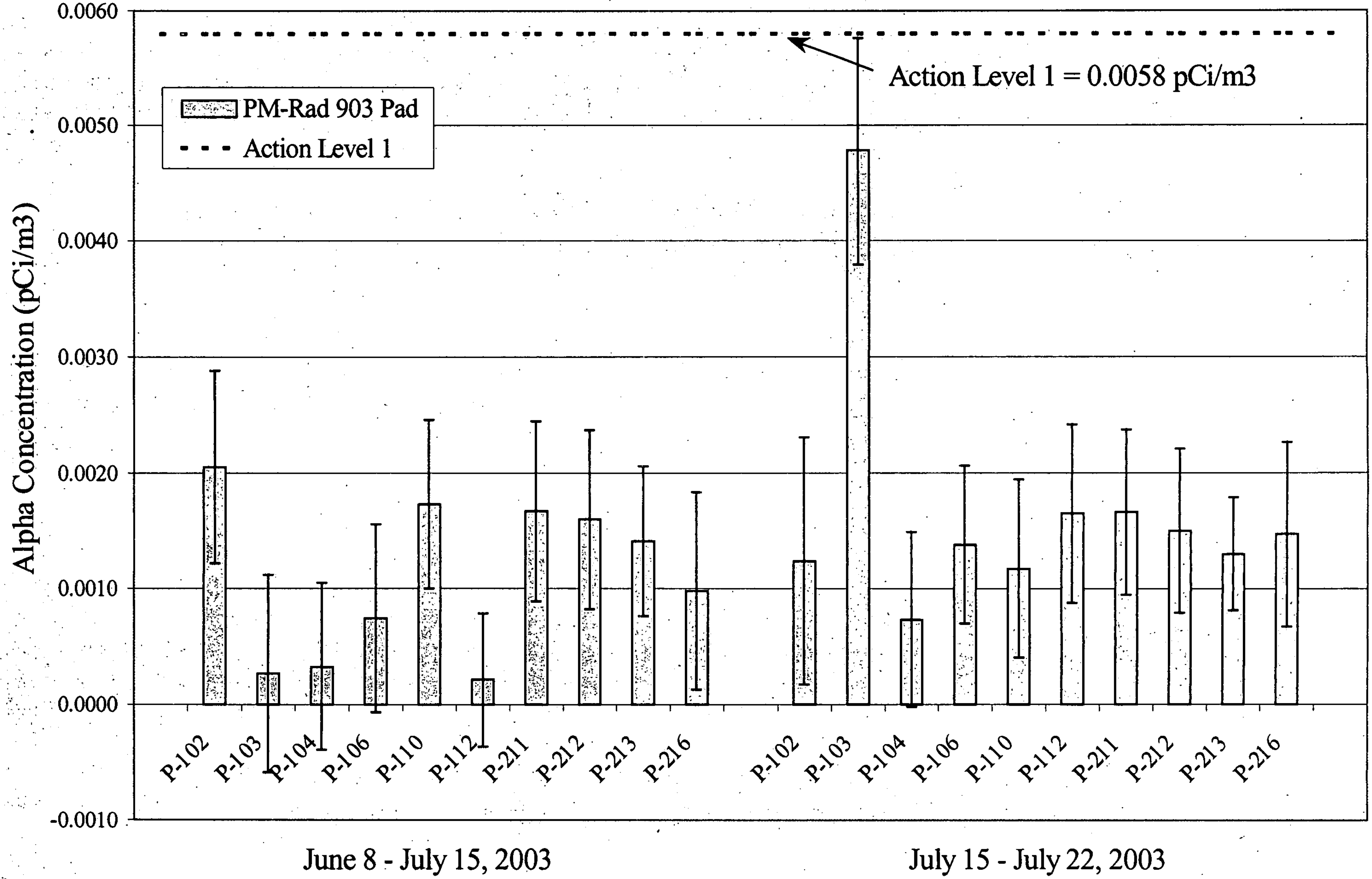
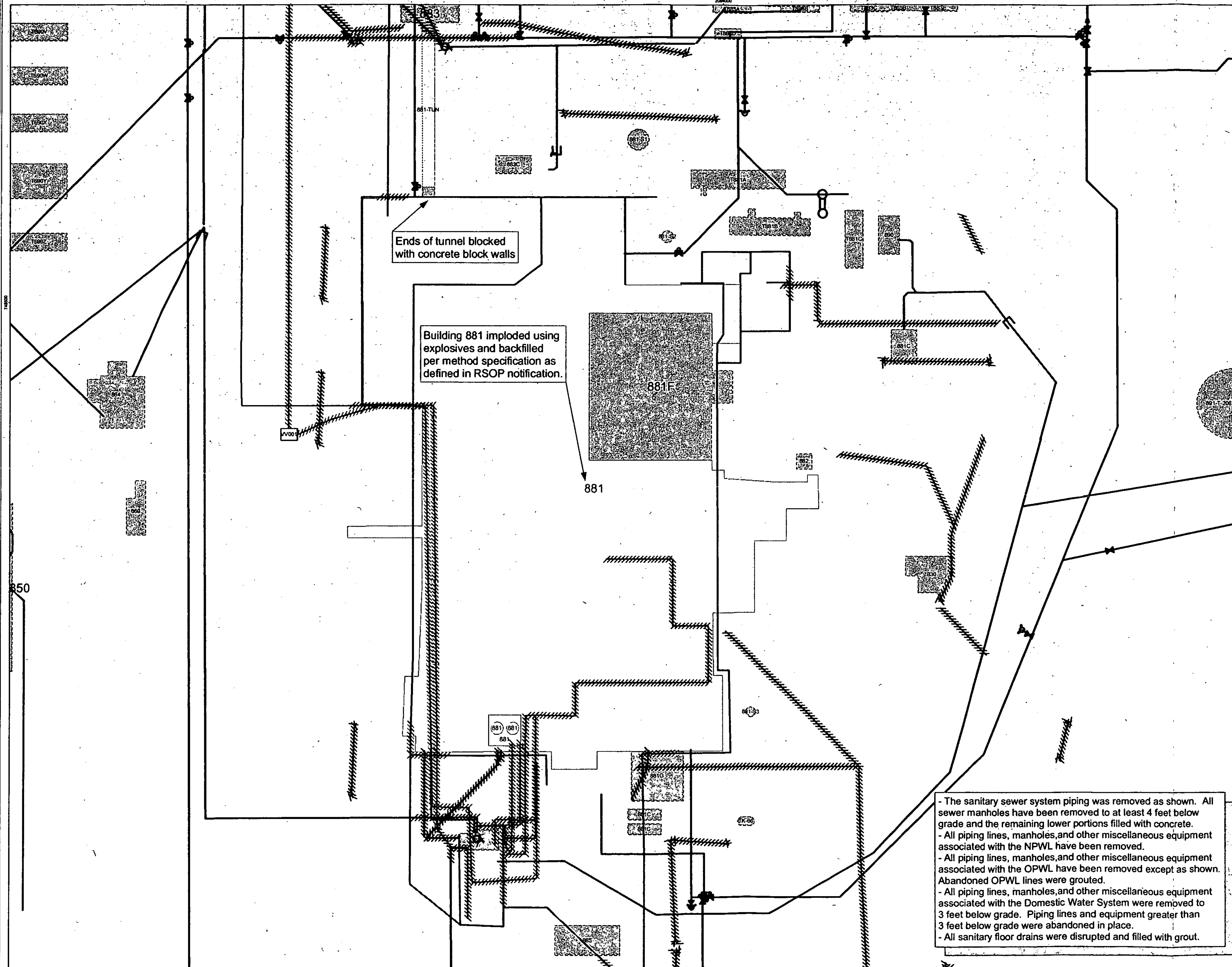
PM-Rad: 903 Pad by Sampler Location, 7/8/03 - 7/22/03

903 Pad remediation began 11/14/02.



Remaining UG Utilities for Building 881 Cluster



- The sanitary sewer system piping was removed as shown. All sewer manholes have been removed to at least 4 feet below grade and the remaining lower portions filled with concrete.
- All piping lines, manholes, and other miscellaneous equipment associated with the NPWL have been removed.
- All piping lines, manholes, and other miscellaneous equipment associated with the OPWL have been removed except as shown. Abandoned OPWL lines were grouted.
- All piping lines, manholes, and other miscellaneous equipment associated with the Domestic Water System were removed to 3 feet below grade. Piping lines and equipment greater than 3 feet below grade were abandoned in place.
- All sanitary floor drains were disrupted and filled with grout.

EXPLANATION

- Foundation Drain
- Sewer
- Domestic Cold Water
- Culverts & Storm Drains
- OPWL
- NPWL

NOTE: Hatched symbols represent removed features.* Color indicates utility type.

Standard Map Features

- Remaining Structure
- Removed Structure

N

25 0 25 50 75 100 Feet

State Plane Coordinate Projection
Colorado Central Zone (3476)
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared By:
CH2MHILL
GIS DEPT. (303) 966-7707

Prepared For:
KAISER•HILL COMPANY

DATE: 9/19/2005

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